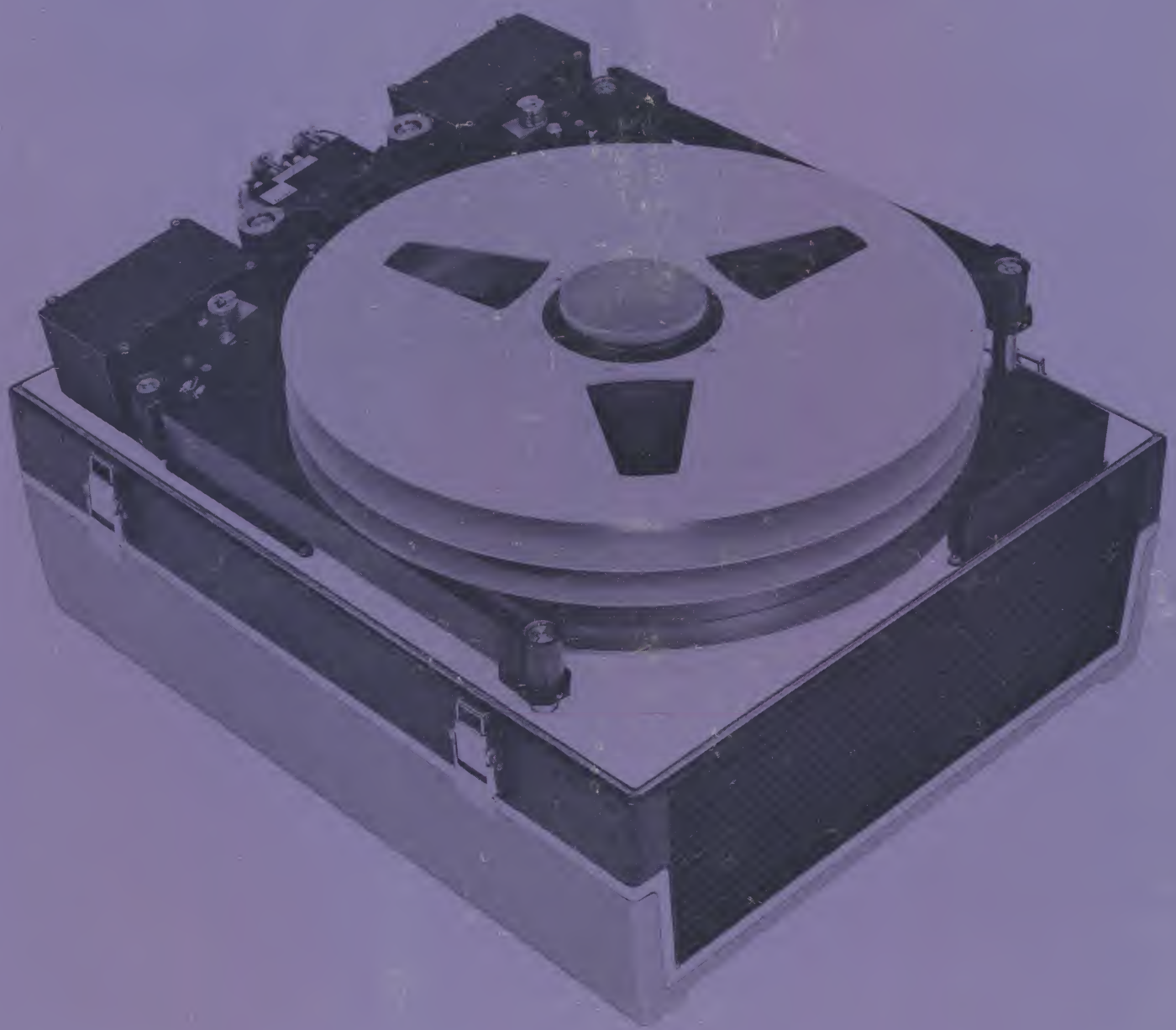
MODEL M-14 SERIES

WIDEBAND TAPE RECORDER/REPRODUCER

Model M–14 Series Wideband Tape Recorder/Reproducer features wideband frequency response and low time base error under hostile environments, combined with minimum size and weight for true portability in airborne and mobile applications.



ASTRO-SCIENCE CORPORATION
AVIONICS INSTRUMENTATION DIVISION

M-14 SERIES ENGINEERED FOR ENVIRONMENTAL INTEGRITY

Astro-Science's Model M–14 Series is the first wideband portable tape recorder/reproducer designed specifically for use in hostile environments typically encountered in airborne, shipboard, and mobile applications. Based upon time-proven and field-tested concepts and techniques, it utilizes the basic dual capstan drive and concentric reel mechanism that was pioneered by Astro-Science and successfully used in hundreds of Astro-Science high environmental recorders. Prior to its incorporation into the Model M–14 Series, the use of a large tape-wrap around the capstans to eliminate pinch rollers was successfully used and tested in several Astro-Science recorders for spaceborne and sounding rocket applications where severe environments are encountered. In essence, the Astro-Science M–14 Series is a new wideband recorder that, in effect, was field-tested at the conceptual stage to ensure laboratory quality performance under hostile environments. The result is a wideband recorder with environmental integrity as well as unexcelled tape transport and signal handling characteristics, combined with minimum size and weight.

M-14 SERIES OPERATING CHARACTERISTICS

Representing a breakthrough in size and weight, the M–14 Series Recorder/Reproducer is the smallest and lightest weight wideband system available that handles 1-inch wide magnetic tape on 14-inch diameter NAB tape reels. It records and reproduces 14-tape tracks in the IRIG configuration with a record/reproduce density of 16,667 cycles per inch, providing a bandwidth of 400 cps to 1 mc ±3 db at 60 ips with proportional bandwidth at other tape speeds. For laboratory quality performance, the direct electronics are phase equalized for pulse response as well as amplitude equalized for flat frequency response. Phase response is adjustable. Utilization of a dual differential capstan drive and a phase-lock dc capstan servo provides bi-directional capability and electrically selectable tape speeds. Servo operated reel motors, controlled by sensing tape tension outside the capstan drive, ensure gentle tape handling and precise tape speed control. Incorporation of these drive mechanisms in the M–14 Series Recorder provides a tape transport with extremely low time base error. • Dynamic skew of less than ±0.3 microseconds at 60 ips between adjacent tracks on the same head stack • Dynamic skew of no more than ±1 microsecond at 60 ips between outside tracks on a given head stack across 1-inch wide tape • Time displacement error of no more than ±0.5 microseconds in a 200 microsecond interval measured along a given tape track at 60 ips. • Wow and flutter of no more than ± 0.3% p-p at 60 ips from 0.2 cps to 10 KC. Performance of this caliber is normally available only in the best large laboratory machines. Now it is available in a lightweight portable/airborne recorder that handles 14-inch reels of 1-inch tape.

TAPE TRANSPORT

CONSTRUCTION

For structural integrity, all major components of the tape transport are mounted on and referenced to a rugged, webbed aluminum, baseplate structure. The magnetic heads and all critical components associated with guiding and driving the tape are mounted on the capstan precision plate assembly, a precision machined casting. This, combined with the self-centering reel hubs and precision construction of the tape guiding elements, ensures precise tape guiding with minimum time base error.

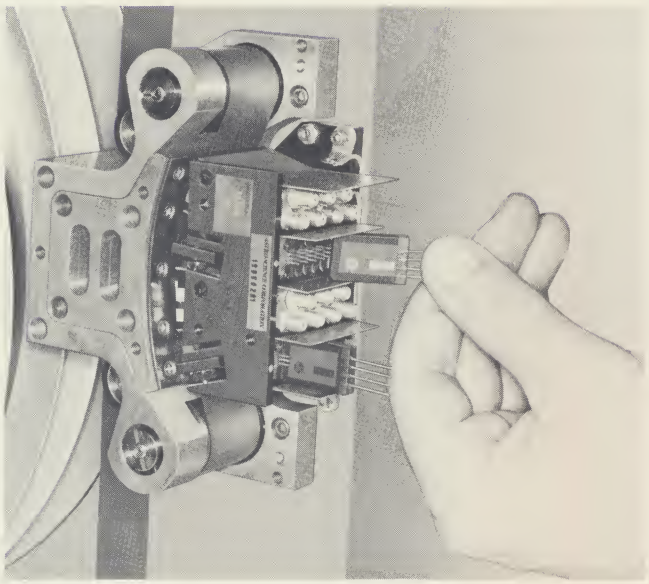
DUAL CAPSTAN DRIVE

The bi-directional dual capstan drive is adapted from the basic dual capstan system used on hundreds of Astro-Science recorders. The dual capstans are driven at differential speeds and hence develop constant dynamic tape tension within the closed-loop of tape across the magnetic heads. Tape tension across the heads is 16 ounces nominal for 1-inch tape, a value well within the elastic limits of the tape that ensures intimate tape-to-head contact with minimum head-to-tape friction. Since the capstan differential is determined by the mechanical tolerances of the capstan drive elements, dynamic tape tension is relatively unaffected by environmental conditions.

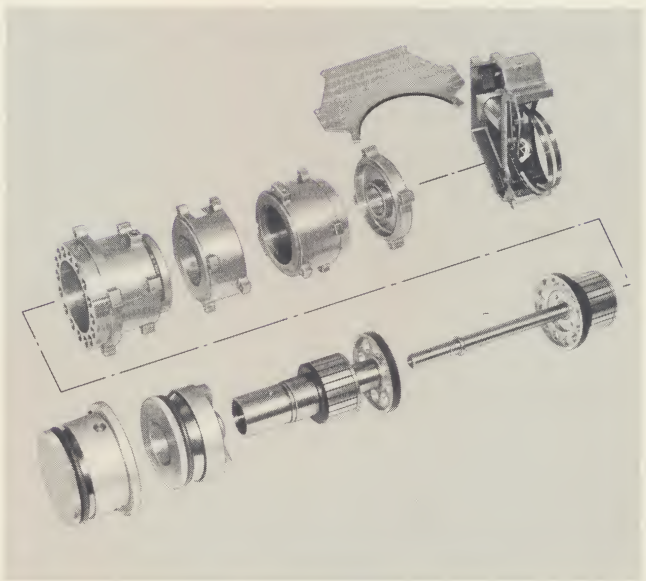
A tape-wrap angle of more than 180° around the capstans develops the necessary *normal* forces to transmit positive drive power from the capstans to the tape. This effectively clamps the tape to the capstans and isolates the reels from the capstan drive without the need for pinch rollers. Elimination of the pinch rollers does away with a primary source of dynamic skew and flutter that is inherent in other drive systems.

CAPSTAN SERVO

For precise tape motion control, a low inertia dc motor and fast response phase-lock servo system are used to drive the capstans. In operation, the fast response servo compares the phase of the speed error reference signal to the crystal reference signal, and drives the capstan motor so that the speed error reference is phase-locked to the crystal reference. The speed error reference is provided by the motor tachometer and hence the motor speed is locked to the crystal. Since the dual capstan drive is symmetrical, tape motion in either direction is achieved simply by reversing the capstan motor.



DUAL CAPSTAN DRIVE



COAXIAL REEL MOTOR ASSEMBLY

REELING SYSTEM

For minimum size and weight, the Recorder handles 10½ or 14-inch NAB reels in a concentric (coaxial) configuration. Each reel is driven by a separate servo-controlled reel motor. The two motors are mounted piggy-back in the same housing, and the motor shafts are concentric as shown. This motor mounting technique has been used for several years by Astro-Science in hundreds of high environmental recorders and has proved to be highly successful. To ensure gentle tape handling, the reel motors are servo controlled. The reel servos sense and regulate supply and takeup tape tension outside the capstan drive to 8 ounces nominal. Solenoid actuated brakes consisting of brake bands that engage brake drums on the motor armatures provide fail-safe parking brakes. Dynamic braking is used for operational modes.

HEADS AND ELECTRONICS

MAGNETIC HEADS

IRIG compatible magnetic heads are used for 14-track operation. The head assembly consists of two interleaved record head stacks and two interleaved reproduce head stacks as shown.

The record head azimuth is perpendicular to the head mounting plate within ± 1 minute of arc. Reproduce head azimuth is adjustable over a range of ± 1 degree of nominal azimuth.

SIGNAL ELECTRONICS

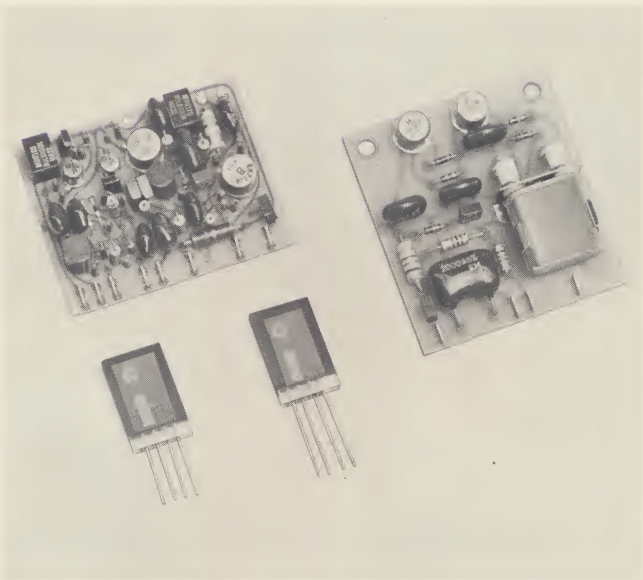
Solid state modular signal electronics are used throughout the Model M–14 Series. Conventional constant flux direct record/reproduce techniques with phase and amplitude equalized electronics are used. To minimize system noise and loss of low level signals through cable capacitance, the record electronics and reproduce preamplifiers are mounted as close as practical to the magnetic heads.

As illustrated, the reproduce preamplifiers are constructed as encapsulated modules that directly plug into the reproduce heads. The wideband (2mc) preamplifiers match the head impedance and provide high gain to drive the low impedance coaxial lines to the equalized reproduce amplifiers, hence minimizing the loss of high frequency head signals through cable capacitance and ensuring maximum signal-to-noise ratio.

The reproduce electronics phase and amplitude equalize the overall direct record/reproduce system, and reproduce equalization is switched automatically with a change in tape speed.

Simplicity of circuitry is a keynote in the design of the M–14 signal electronics. To illustrate the simplicity of the circuits, up to 14 direct record amplifiers are mounted adjacent to the capstan drive on top of the precision plate within six inches of the record heads, and the reproduce preamplifiers plug-in directly to the reproduce heads. This concept in circuit design minimizes the problem of driving long coaxial lines with low level, high frequency signals and thus helps ensure the superior performance typified by the M–14 Series.

MAGNETIC HEADS AND PREAMPS



TYPICAL SIGNAL ELECTRONICS

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M-14A SPECIFICATIONS

This specification sheet summarizes the performance characteristics of the Astro-Science Model M–14A Airborne/Portable Wideband Recorder/Reproducer, which is one of the several versions of the M–14 Series.

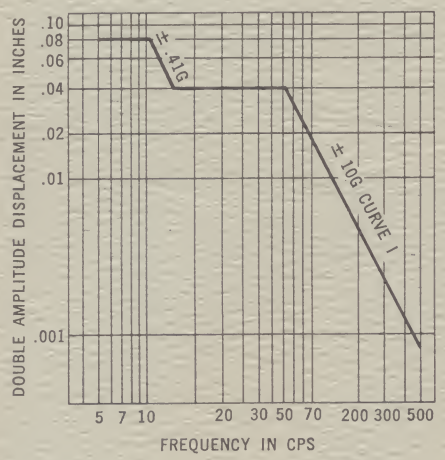
GENERAL

Size: Outline dimension 20¼" x 16" x 10¼" for basic recorder with 14 channels of record electronics. See illustration for sway space limits with vibration isolators. On special order 19" rackmount adapters are available.

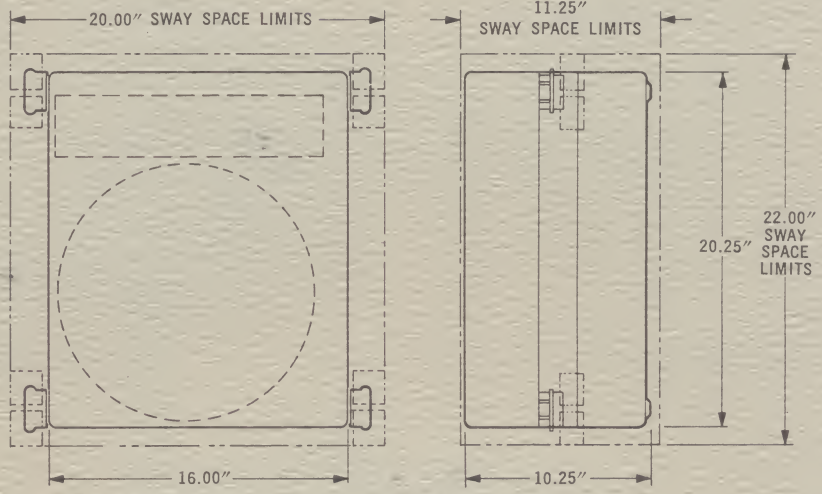
Weight: 65 pounds for basic recorder with 14 channels of record electronics, including a full 14" reel of tape and empty takeup reel.

Power: Basic Recorder operates from +26 to +32 volt dc aircraft power, with 8 amperes maximum current consumption. On special order, power converters are available for operation from 115 VAC, 47-420 cps, single-phase ac power.

Connectors: Miniature coaxial connectors are used on the basic recorder for signal input. BNC connectors are used on the monitor unit for signal outputs. Power and remote connectors are aircraft MS type.



VIBRATION REQUIREMENT PER MIL-E-5400



OUTLINE DIMENSIONS

PHYSICAL ENVIRONMENT

Temperature: 0°F (—18°C) to +130°F (+54°C) without the need for external heating or cooling.

Altitude: Sea level to 34,000 feet.

Relative Humidity: To 95% (without condensation)

Shock: Withstands 15G for 11 milliseconds (30G crash safety).

Vibration: Per MIL-E-5400 vibration curve I illustrated above, with vibration isolators installed.

TAPE TRANSPORT

Tape Speeds: 7½, 15, 30, and 60 ips, electrically selectable.

Speed Accuracy: ± 0.2% of nominal.

Tape and Reel Size: 1-inch wide tape on 14-inch diameter NAB reels. Specifications are based upon the use of precision reels and Memorex Type 62L tape.

Flutter: Measured from 0.2 cps to 10 KC at 60 ips under the following environment:

steady state condition	Vibration Curve 1 (± 10G with Vibration Isolators)
0.3% p-p	0.6% p-p

Dynamic Skew: No more than ± 0.3 microseconds at 60 ips between adjacent tracks on the same head stack. No more than ± 1 microsecond at 60 ips between outside tracks on a given head stack across 1-inch tape.

Time Displacement Error: No more than ± 0.5 microsecond in a 200 microsecond interval at 60 ips measured on any given track under steady state conditions; ± 1 microsecond in a 200 microsecond interval at 60 ips measured on any given tape track under specified vibration conditions.

Start Time: 4 seconds to stable tape motion at 60 ips.

Stop Time: Less than 3 seconds from 60 ips.

Bi-Directional Operation: Operates in forward and reverse.